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Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) ABRASIVE BLOCK FOR MACHINING RAILS

(57) Vehicle for machining a rail (1) by grinding and/or planing, comprising a mobile chassis and a metal abrasive module (2) for grinding and/or planing the rail, the metal abrasive module comprising an eccentric drive (3) performing an eccentric movement, at least one abrasive block (4) mechanically connected with the eccentric drive and a force exerting drive pressing the abrasive block onto the rail, wherein the abrasive block and/or the metal abrasive module has a first hollow channel (9). This allows a more effective and improved metal removal and rail shaping capabilities, including the delivery of fluid i. a. for cooling.

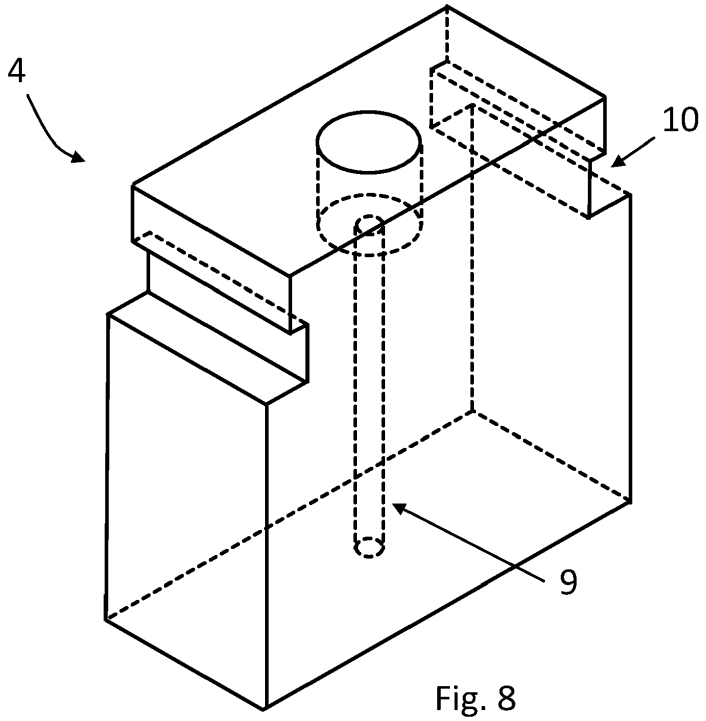

Fig. 8

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Description

FIELD OF THE INVENTION

[0001] The invention relates to the field of mobile treatment of rails with an abrasive rail planing module comprising of one or more abrasive blocks which are in contact with the rail. In particular the present invention relates to the field of mobile rail treatment wherein the abrasive blocks are pressed onto the rails by an eccentric drive and cooling fluid is delivered to the surface of the rail. The related technology - for instance integrated into a vehicle or module - allows for removing rail surface irregularities such as corrugations, near surface defects, and millscale.

BACKGROUND OF THE INVENTION

[0002] Steel wheels from trains running on steel rails cause for wear and fatigue damage to both components. Wear and fatigue damage on rails mainly occur on the head and shoulders of the rails. High traction forces, acceleration and/or deceleration and curving of trains all contribute to the occurrence of such wear and rolling contact fatigue damages. For extending the life of rails, a minimization of damages to a related track and/or vehicle components as well as a minimization of noise and vibration, which are issues to passengers and nearby residents, are required. It is therefore necessary that rails are maintained.

[0003] To avoid a replacement of entire rails with surface irregularities such as corrugations, near surface defects and millscale, a maintenance is often performed by on-site treatment of rails. Therefore, often a wagon is equipped with grinding tools which allow metal removal by, for instance, grinding or milling of the rail surface with the help of stones performing movements to remove metal. The related abrasive blocks are usually connected to a drive which performs oscillating movements. Rotational grinding, oscillating block grinding, planing, milling and rotational planing are all common mobile rail treatment methods used to either bring rails in shape or keep rails in shape. Each of these methods have their specific advantages and disadvantages.

[0004] Often ridges and irregularities can be removed from rail head surfaces by means of a travelling on-track planing, shearing and grinding machine with related tool supports. The tool supports provided for each rail are typically pivotally interconnected through spacers adjustable in length transversely of the longitudinal axis of the machine. A set of tools is arranged opposite one another for each rail. The tool support is provided with guide rollers guided firmly along the upper surface and outside of the rail head. The known drives for grinding usually have a relatively small stroke which is often tried to be compensated by higher frequencies or forces with which the abrasive block is pressed onto the rail.

[0005] The machining tools and related machines for rail treatment usually leave the removed metal on or next to the rail. Hence all debris - including a mixture of water, dust, abrasive residue and metal - produced by the existing technologies stays behind on the tracks which requires additional and subsequent cleaning in case of rails surrounded, for instance, by asphalt. In existing grinding machines a relatively short longitudinal or sliding movement of a grinding block is performed due to the nature of the rotational to linear movement mechanism which often means debris remains between stone and rail and is not cleared which in turn results in low metal removal. A rotational to linear movement mechanism is often achieved through gearboxes with excenter mechanisms.

[0006] In existing machines often multiple blocks are fitted in a sort of moving ruler or bar and cooling water is delivered roughly from the sides of the grinding blocks. The existing rail grinding technology only works with the use of significant amounts of water for cooling the stones, typically this technology requires a few thousands of liter water to function, water is sprayed ahead and behind each grinding stone. Hence, significant amounts of water are wasted.

SUMMARY OF THE INVENTION

[0007] It is an object of the invention to provide a method and a related machine for mobile rail treatment with improved characteristics.

[0008] According to the invention, this object is addressed by the subject matter of the independent claims. Preferred embodiments of the invention are described in the sub claims.

[0009] The invention aims inter alia in reducing the amount of required water and improving the mobile rail treatment by an increased removal rate combined with low wear on an abrasive block by efficient cooling and water delivery, leaving a very low residual roughness from the machining process and without leaving any significant dust and/or debris on the track. Further, the invention improves mobile rail treatment by using a method which does not produce any sparks.

[0010] According to the invention a vehicle for machining a rail by grinding and/or planning is provided, comprising a mobile chassis and a metal abrasive module for grinding and/or planing the rail, the metal abrasive module comprising an eccentric drive performing an eccentric movement, at least one abrasive block mechanically connected with the eccentric drive and a force exerting drive pressing the abrasive block onto the rail, wherein the abrasive block and/or the metal abrasive module has a first hollow channel.

[0011] The invention allows for high performance mobile rail treatment suitable for removing rail surface irregularities such as corrugations, near surface defects and millscale. Furthermore, high metal removal capabilities combined with leaving a very low residual machining roughness are achieved by the invention. An abrasive

block - preferably tiltable around an axis parallel to the rail - allows a complex machining of the metal surface and therefore - related to rails - the head and/or shoulder. The invention also provides a machining technology for mobile rail treatment which is suitable for implementation in a vehicle or train.

[0012] The vehicle may also be a wagon or a train car or another mobile service car including those used for trams and/or trains or other rail bound vehicles. The abrasive block can comprise a hard material in form of a stone and/or crystal and/or ceramic and/or a material compound including several materials.

[0013] In another embodiment of the invention, the channel extends basically perpendicularly to the direction of the rail. In this way a direct channel with a little length is provided, guiding to the contact surface of the abrasive block 4 with the rail.

[0014] Preferably the first hollow channel has a first opening and a second opening. The abrasive block 4 may have a simple through hole so that a direct channel to the rail is provided which is easy to manufacture. I another embodiment, the first opening and/or the second opening has a bigger diameter than an inner section of the channel. This can facilitate the use of the channel related to positioning tolerances towards fluid injectors in the holding structures or the metal abrasive module which typically holds the abrasive block.

[0015] In a special embodiment the first hollow channel is filled with a coolant and/or fluid and/or the first hollow channel is configured to guide a coolant and/or fluid. This allows to cool the abrasive module 4 and/or the rail, for instance with water or other fluids as well as mixtures of fluids or even air. It could also be thought of inner reservoirs for a coolant which may be exchanged permanently or only sometimes. In case the first hollow channel is configured to guide a coolant and/or fluid from the metal abrasive module through the abrasive block to the contact surface with the rails, this allows a permanent cooling of the components and usually results in higher removal rates and a longer lifetime of the involved components, mainly the abrasive block. Further removed metal and further particles can be moved away or to the sides of the abrasive block which can increase the removal rate since resting material between rail and abrasive block can act as a lubricant and hence reduce the removal rate.

[0016] Preferably the first hollow channel is configured to guide a coolant and/or fluid to a contact surface of the abrasive block with the rail. This allows for an effective cooling and a simultaneous removal of removed metal.

[0017] In a preferred embodiment of the invention, the first hollow channel is configured to allow suction of debris and/or metal chips from the rail and/or from the environment of the rail. This allows also for increased metal removal rates since the removed metal would otherwise act as a lubricant. It can also be thought of a dual use of a hollow channel which temporarily delivers a coolant and in other instances allows the suction of debris and/or metal chips.

[0018] Preferably the abrasive block and/or the metal abrasive module has a second hollow channel with a first opening and a second opening. The second hollow channel can have the same of the two already described functions or a different function than the first hollow channel. The metal abrasive module can have similar channels than the abrasive block, especially in order to feed coolant or other fluids to a channel of the abrasive block.

[0019] In a further embodiment of the invention, the second hollow channel is configured to guide a coolant and/or fluid to a contact surface of the abrasive block and/or the metal abrasive module with the rail and/or the second hollow channel is configured to allow suction of debris and/or metal chips from the rail and/or from the environment of the rail. Typically, the use of a second hollow channel can increase the metal removal rate - by better cooling and/or better removal of the removed metal.

[0020] Preferably the first hollow channel and/or the second hollow channel has a section extending substantially vertically and/or has a free-formed section. A vertical channel section can allow a quick delivery of the coolant or another fluid to the rail. One or more free-formed sections of the first and/or second hollow channel can improve the flow of the fluid and allow lower resistance of a fluid stream or a better distribution of the fluid in terms of cooling function and/or stability of the abrasive block.

[0021] In a special embodiment the first hollow channel and/or the second hollow channel have an opening on top and on the bottom of the abrasive block and/or the metal abrasive module. This is especially the case for a through hole guiding a fluid directly to the rail's surface. The opening on top of the abrasive block can also be at one of the sides, for instance in case the fluid is injected from one of the sides, preferably by a hose or pipeline. By this, more freedom for the design of the mounting or clamping mechanism of the abrasive module can be provided. Further, a sealing at the inlet of the abrasive module for a fluid can potentially be realized more easily.

[0022] Related to the manufacturing method of the abrasive block, this can preferably be performed by hot embossing and/or additive manufacturing and/or chemical etching techniques. The abrasive block can also be manufactured by pressing, casting, or other methods allowing to produce a block that is hard and/or stable enough for removing metal from a rail by grinding and/or planing. Further, the abrasive block basically can have a relatively simple outer geometry in form of a cuboid, but a free-formed, individually designed geometry can be of advantage especially when considering special forms of the rail surface.

[0023] The invention comprises also a method for machining a rail by grinding and/or planing, comprising the steps of approaching the surface to be machined until contact with a metal abrasive module having at least one abrasive block, wherein the metal abrasive module is

mounted on a vehicle, and performing movements with the abrasive block while pressing the abrasive block onto the rail, further guiding a fluid and/or a coolant to the contact surface of the rail and the abrasive block through a first hollow channel in the abrasive block. In this way the metal removal rate can be significantly increased.

[0024] Preferably the method further comprises the step of suction of debris and/or metal chips in the vicinity of the abrasive block through the first hollow channel. This allows at least the suction of debris etc. for every abrasive block.

[0025] The method further comprises the step of alternating suction of debris and/or metal chips in the vicinity of the abrasive block through the first hollow channel and guidance of coolant through the first hollow channel.

[0026] Preferably the method further comprises the step of suction of debris and/or metal chips in the vicinity of the abrasive block through a second hollow channel within the abrasive module. Especially in case of guiding coolant through the first channel, the suction of debris and/or metal chips can be performed simultaneously allowing again for higher removal rates.

[0027] The eccentric drive usually can comprise a drive which is coupled to a turning motor, wherein the eccentric drive transforms the oscillation or other motion of the motor into eccentric movements. Preferably, a translational movement component of at least one of the abrasive blocks is longer than the length of said abrasive block. In this way the removed metal, which may often stay between the rail and the abrasive block for several periods of the oscillating movement of the abrasive block, is moved faster to the sides of the abrasive block. Hence the removal rate of the mobile rail treatment is increased since the abrasive block is more in direct contact with the rail surface. Preferably the eccentric movement has a scotch yoke type mechanism having a reciprocating motion mechanism which transforms the linear motion of a slider into rotational motion or vice versa. The advantage of a scotch yoke type mechanism can be the realization of a high amplitude - especially of the translational component of the movement - and/or a high acceleration and/or a high pressure and/or a high velocity, which may all contribute to an increased removal rate of metal of the rails.

[0028] In another realization of the invention multiple abrasive blocks are coupled together which can therefore work as a sliding ruler. Typically, every further added abrasive block increases the length of the rail which can be treated simultaneously. However, it is also advantageous to limit the length of each abrasive block so that removed metal is moved more efficient to an outside of an abrasive block. Hence, it is advantageous to limit the overall length of each abrasive block and use multiple abrasive blocks which can also be positioned individually

[0029] In a special embodiment, the metal abrasive module and/or at least one of the abrasive blocks is - preferably individually - tiltable around an axis parallel to the rail, and wherein at least one of the abrasive blocks is individually pressable onto the rail. This allows for an improved reshaping of rails since the desired profile of a rail is not only plane, but is similar to a curve, in more detail with a so-called head and a shoulder.

[0030] Preferably, the eccentric drive is driven by a variable frequency electric motor and/or a hydraulic drive. A variable frequency electric motor allows for adjustment of the power and rounds per minute and hence the rotational speed. Further these can be relatively efficient in power consumption. A hydraulic drive is often already available and therefore, no extra motor or drive is required.

[0031] In a further realization, the abrasive module can be tilted from vertical towards an outer side and/or inner side of the rail. This allows, e.g., for shaping the head and/or the shoulder of a rail. Conventional system in state of the art allow only a fixed angle towards the rail which reduces the possibilities to efficiently reshape rails.

[0032] In a special embodiment of the invention, the vehicle and the abrasive module further comprises a debris suction head in the vicinity of the contact surface of the metal abrasive module with the rail. This allows to remove at least most of the removed metal from the rail and no or only little of the removed metal is left in the vicinity after treatment of the rail.

[0033] Further it is preferred that the vehicle comprises a guide roller in the vicinity of the metal abrasive module and/or abrasive block, wherein the guide roller is in contact with the rail allowing i. a. for machining rails in tight curves. The guide roller may also contribute to less vibrations of the system and it may also comprise an opening near the surface of the rail for suction of removed metal. In a further realization at least two abrasive modules are each connected to an individual guide roller. This can significantly improve the quality of the guiding mechanism, improve security measures etc. and hence allow narrow curves.

[0034] It is further preferred that the abrasive module is connected to a guide roller with a - preferably integrated - debris suction head. The suction head can be located in front or in the rear of the guide roller and. It can also be thought of - preferably multiple - suction heads or channels, which - in a special embodiment - may be distributed and/or integrated around the guide roller.

[0035] The invention further allows a machining of a rail by grinding and/or planing, comprising the steps of approaching a surface to be machined until contact with a metal abrasive module with at least two abrasive blocks connected with a vehicle, tilting the metal abrasive module and/or at least one abrasive block parallel to a desired surface form, and performing eccentric movements with the metal abrasive module while pressing the metal abrasive module onto the rail.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036] These and other aspects of the invention will be apparent from and elucidated with reference to the em-

bodiments described hereinafter. Such an embodiment does not necessarily represent the full scope of the invention, however, and reference is made therefore to the claims and herein for interpreting the scope of the invention.

[0037] In the drawings:

Fig. 1 schematically depicts a vehicle on rails having a metal abrasive module according to one embodiment of the invention,

Fig. 2 schematically depicts an embodiment of the metal abrasive module,

Fig. 3 schematically depicts an embodiment of the metal abrasive module with abrasive blocks being positioned in different angles,

Fig. 4 schematically depicts magnified excerpts of each of the three figures in Fig. 3,

Fig. 5 schematically depicts an embodiment of the guide roller,

Fig. 6 schematically depicts the guide roller of Fig. 5 including a mount for attaching to the metal abrasive module,

Fig. 7 schematically depicts one embodiment of the abrasive block and

Fig. 8 schematically depicts the abrasive block in a 3D-view including a channel.

DETAILED DESCRIPTION OF EMBODIMENTS

[0038] Figure 1 schematically shows a vehicle on rails having a metal abrasive module 2 with three abrasive blocks 4, wherein a guide roller 7 is attached to the metal abrasive module 2. The vehicle may also be a wagon or a train car or a service or maintenance car and allows to carry the metal abrasive module 2 to the place where a treatment of the rails is required.

[0039] In Fig. 2 one embodiment of the metal abrasive module 2, which can be attached to a chassis or a frame of the vehicle, with three abrasive blocks 4 and a guide roller 7 is shown. Further, the force exerting drive 5 for pressing the abrasive blocks 4 is depicted, which has the form of a hydraulic cylinder. The hydraulic cylinder presses also the part of the metal abrasive module 2 downwards in direction of the rails 1, which performs the eccentric movements.

[0040] The metal abrasive module 2 is schematically depicted in Fig. 3 with abrasive blocks 4 being positioned in different angles in a.), b.) and c.) towards the head of the rail 1 and with magnified excerpts of each of the three shown cases in Figs. 4 a.), b.) and c.). By tilting the abrasive blocks 4, an adapted or optimized treatment of the profile form of the rails can be realized.

[0041] In Fig. 5 one embodiment of the guide roller 7 is shown in more detail from a side perspective. The guide roller 7 is illustrated with a debris suction head 6 adjacent to the guide roller 7. It can also comprise a channel for a vacuum and can have a separate suspension. The roller is usually made of steel, but can be of any other material which is adequate to a specific application.

[0042] In Fig. 6 schematically depicts the guide roller 7 of Fig. 5 in a perspective which is 90 degrees turned. Also shown is a mount in the middle of Fig. 6 for attaching the guide roller 7 to the metal abrasive module 2. In the left part of Fig. 6 a hydraulic cylinder is depicted that exerts force onto the lower part of the guide roller 7.

[0043] Figure 7 schematically depicts two side views a.) and b.) of one embodiment of the abrasive block 4 which can substantially have the form of a cuboid. A recess 10 on one or two upper portions may serve for mounting the abrasive block 4 onto a rail system or another mounting or clamping mechanism or systems for holding the abrasive block 4. In the abrasive block 4 a simple hollow channel 9 is shown having the form of a cylindric bore allowing to guide a cooling fluid to the contact surface of the abrasive block 4 and the rail 1. Figure 8 basically depicts the abrasive block of Fig. 7 in a 3D-view including the hollow channel 9 in form of a vertical and straight cylinder. The upper part of the cylinder has a wider diameter. This may allow bigger tolerances related to the positioning of the abrasive block 4 towards an outlet of a possible fluid delivery device or a suction device which both can be integrated in the metal abrasive module 2.

[0044] While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope. Further, for the sake of clearness, not all elements in the drawings may have been supplied with reference signs.

REFERENCE SYMBOL LIST

[0045]

Rail	1

(continued)

Metal abrasive module	2
Eccentric drive	3
Abrasive block	4
Force exerting drive	5
Debris suction head	6
Guide roller	7
Mobile chassis	8
Hollow channel	9
Recess	10

Claims

1. Vehicle for machining a rail (1) by grinding and/or planing,
comprising a mobile chassis (8) and a metal abrasive module (2) for grinding and/or planing the rail (1), the metal abrasive module (2) comprising

    - an eccentric drive (3) performing an eccentric movement,
    - at least one abrasive block (4) mechanically connected with the eccentric drive (3),
    - a force exerting drive (5) pressing the abrasive block (4) onto the rail (2),

    wherein the abrasive block (4) and/or the metal abrasive module (2) has a first hollow channel (9).

2. Vehicle according to claim 1, wherein the channel (9) extends substantially perpendicularly to the direction of the rail (1).

3. Vehicle according to any of the preceding claims, wherein the first hollow channel (9) has a first opening (7) and a second opening (8).

4. Vehicle according to any of the preceding claims, wherein hollow channel (9) is filled with a coolant and/or fluid and/or the hollow channel (9) is configured to guide a coolant and/or fluid.

5. Vehicle according to any of the preceding claims, wherein the first hollow channel (9) is configured to guide a coolant and/or fluid to a contact surface of the abrasive block (4) with the rail (1).

6. Vehicle according to any of the preceding claims, wherein the first hollow channel (9) is configured to allow suction of debris and/or metal chips from the rail (2) and/or from the environment of the rail (1).

7. Vehicle according to any of the preceding claims, wherein the abrasive block (4) and/or the metal abrasive module (2) has a second hollow channel with a first opening and a second opening.

8. Vehicle according to any of the preceding claims, wherein the second hollow channel is configured to guide a coolant and/or fluid to a contact surface of the abrasive block (4) and/or the metal abrasive module (2) with the rail (1) and/or the second hollow channel is configured to allow suction of debris and/or metal chips from the rail (1) and/or from the environment of the rail (1).

9. Vehicle according to any of the preceding claims, wherein the first hollow channel (9) and/or the second hollow channel has a section extending substantially vertically and/or has a free-formed section.

10. Vehicle according to any of the preceding claims, wherein the first hollow channel (9) and/or the second hollow channel have an opening on top and on the bottom of the abrasive block (4) and/or the metal abrasive module (2).

11. Vehicle according to any of the preceding claims, wherein the abrasive block (4) is manufactured by hot embossing and/or additive manufacturing and/or chemical etching techniques.

12. Method for machining a rail (2) by grinding and/or planing, comprising the steps of

    - approaching the surface to be machined until contact with a metal abrasive module (2) having at least one abrasive block (4), wherein the metal abrasive module (2) is mounted on a vehicle,
    - performing movements with the abrasive block (4) while pressing the abrasive block (4) onto the rail (1),
    - guiding a fluid and/or a coolant to the contact surface of the rail (1) and the abrasive block (4) through a first hollow channel (9) in the abrasive block (4).

13. Method according to the foregoing claim, further comprising the step of suction of debris and/or metal chips in the vicinity of the abrasive block (4) through the first hollow channel (9).

14. Method according to the foregoing two claims, further comprising the step of alternating suction of debris and/or metal chips in the vicinity of the abrasive block (4) through the first hollow channel (9) and guidance of coolant through the first hollow channel (9).

15. Method according to claim 12, further comprising the step of suction of debris and/or metal chips in the vicinity of the abrasive block (4) through a second

hollow channel within the abrasive module (4).

Amended claims in accordance with Rule 137(2) EPC.

1. Method for machining a rail (2) by grinding and/or planing, comprising the steps of

   - approaching the surface to be machined until contact with a metal abrasive module (2) having at least one abrasive block (4), wherein the metal abrasive module (2) is mounted on a vehicle,
   - performing movements with the abrasive block (4) while pressing the abrasive block (4) onto the rail (1),
   - guiding a fluid and/or a coolant to the contact surface of the rail (1) and the abrasive block (4) through a first hollow channel (9) in the abrasive block (4).

2. Method according to claim 1, further comprising the step of suction of debris and/or metal chips in the vicinity of the abrasive block (4) through the first hollow channel (9).

3. Method according to claim 1 or 2, further comprising the step of alternating suction of debris and/or metal chips in the vicinity of the abrasive block (4) through the first hollow channel (9) and guidance of coolant through the first hollow channel (9).

4. Method according to claim 1, further comprising the step of suction of debris and/or metal chips in the vicinity of the abrasive block (4) through a second hollow channel within the abrasive module (4).

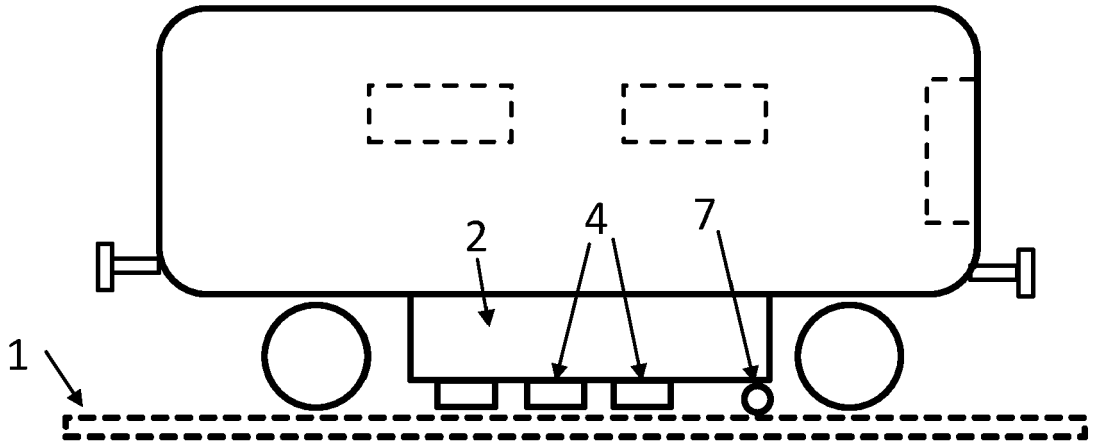

Fig. 1

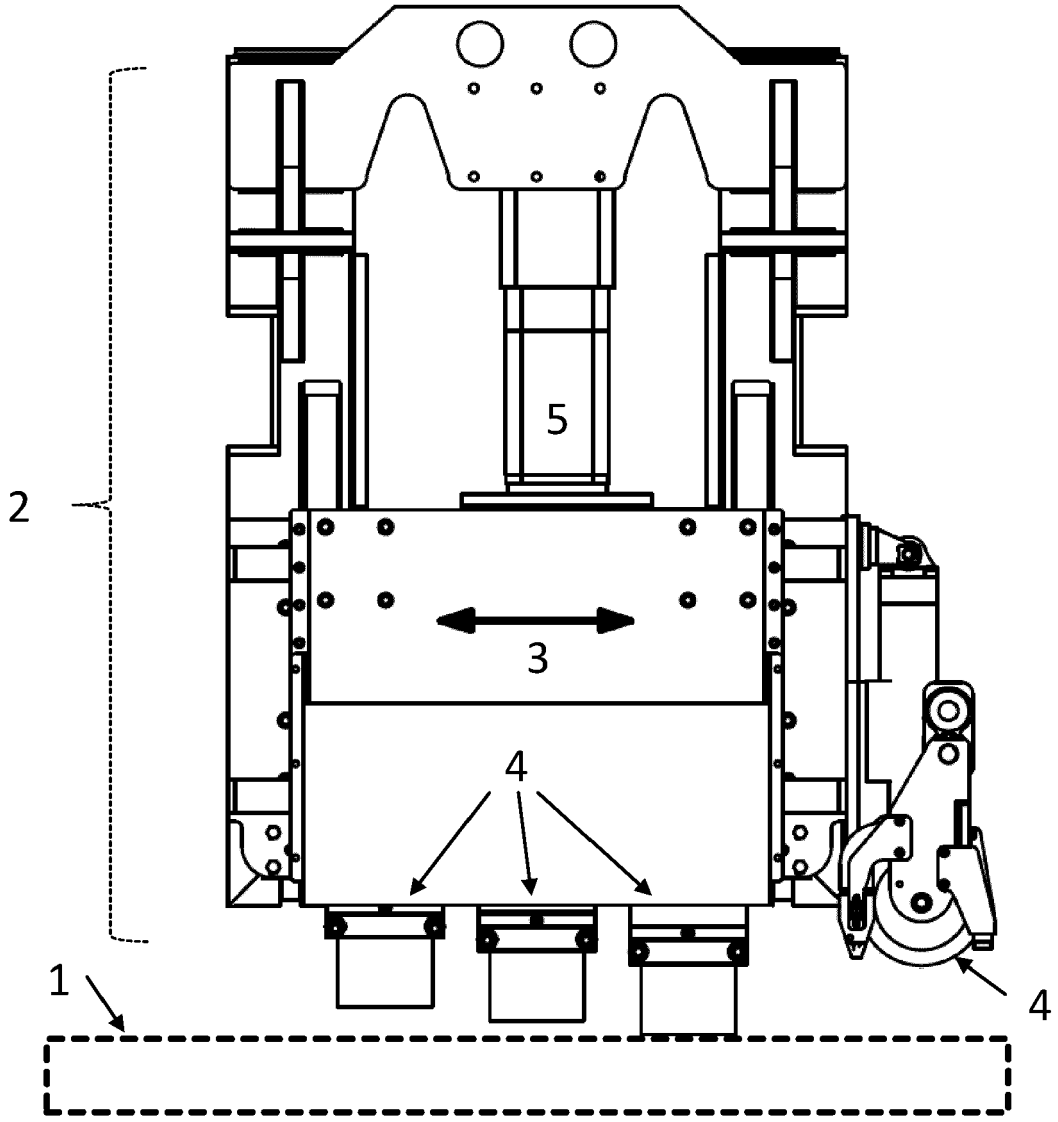

Fig. 2

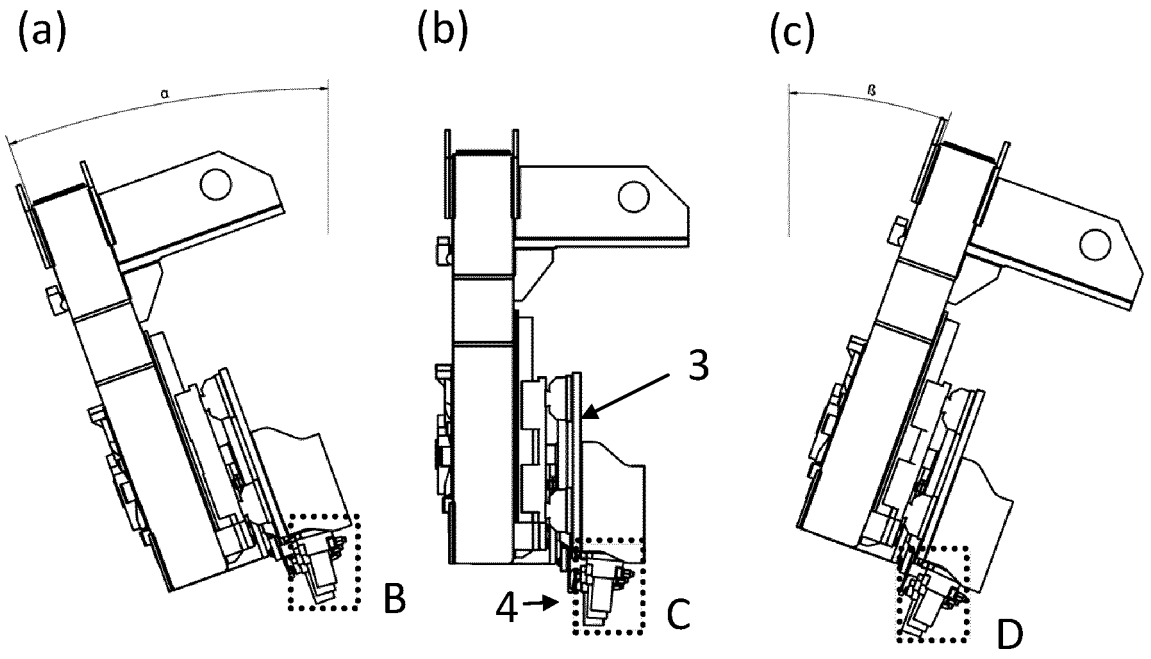

Fig. 3

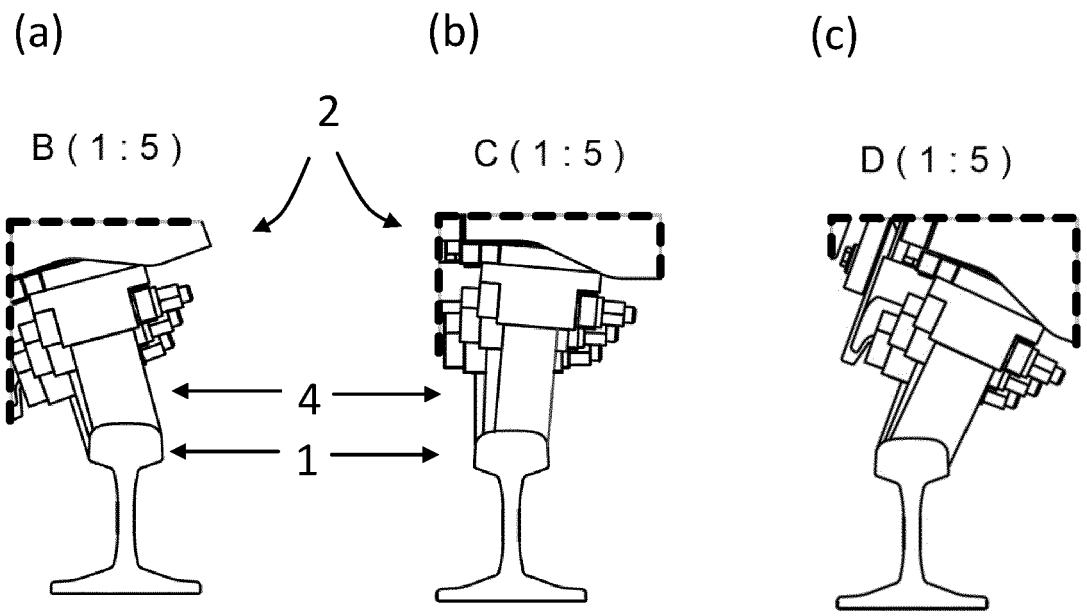

Fig. 4

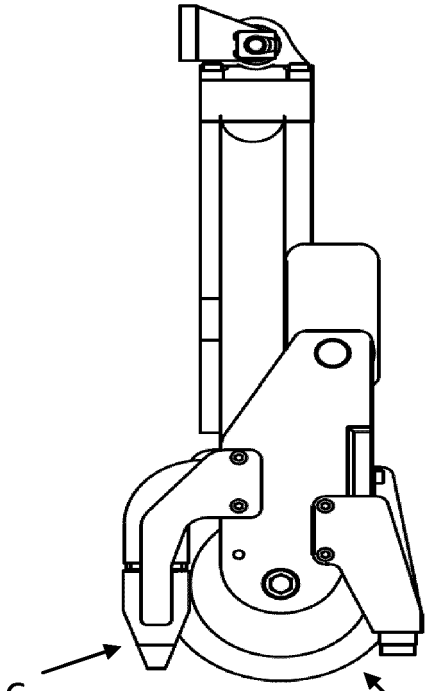

Fig. 5

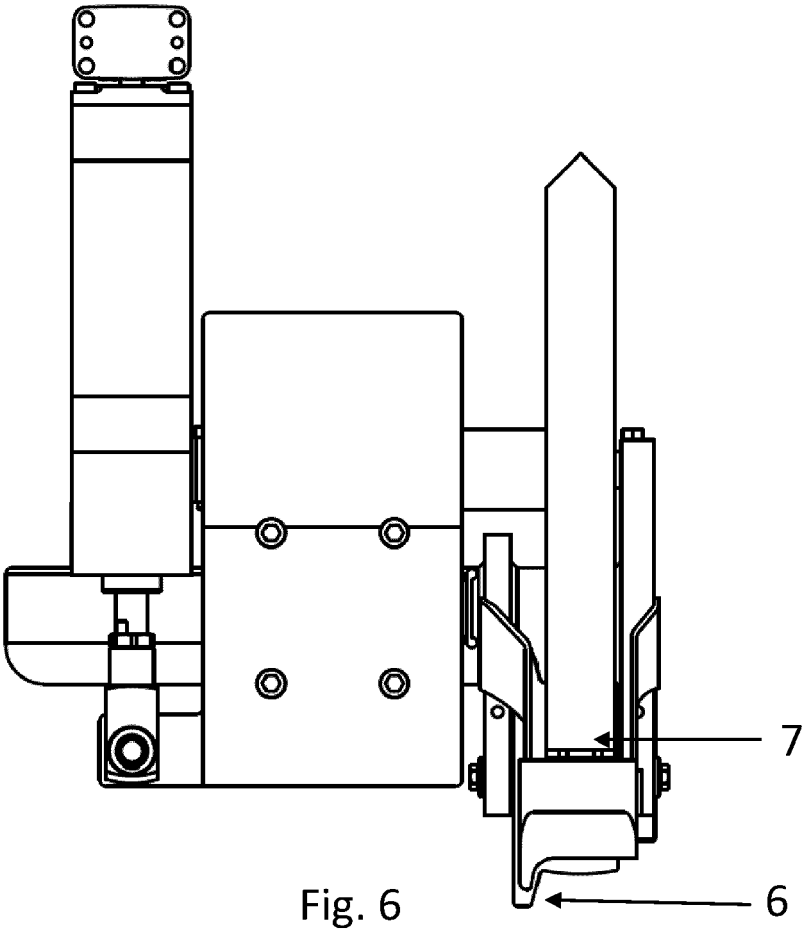

Fig. 6

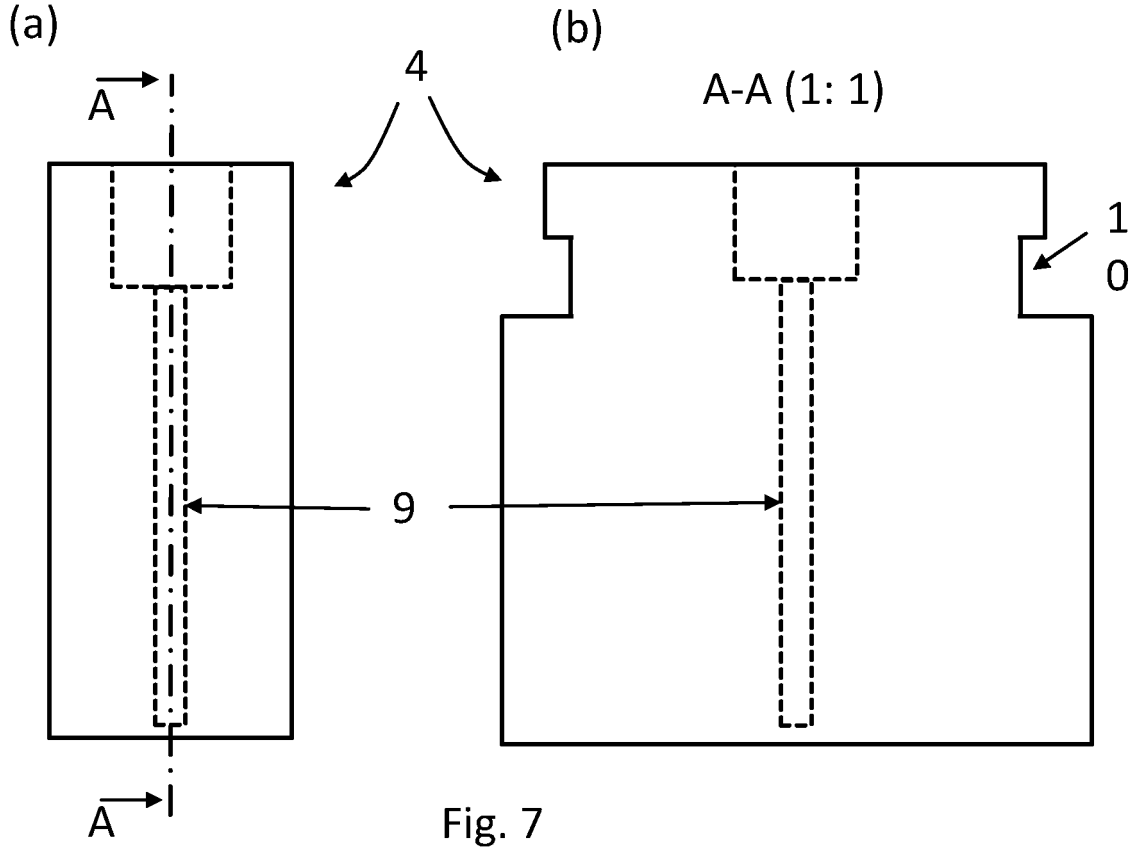

Fig. 7

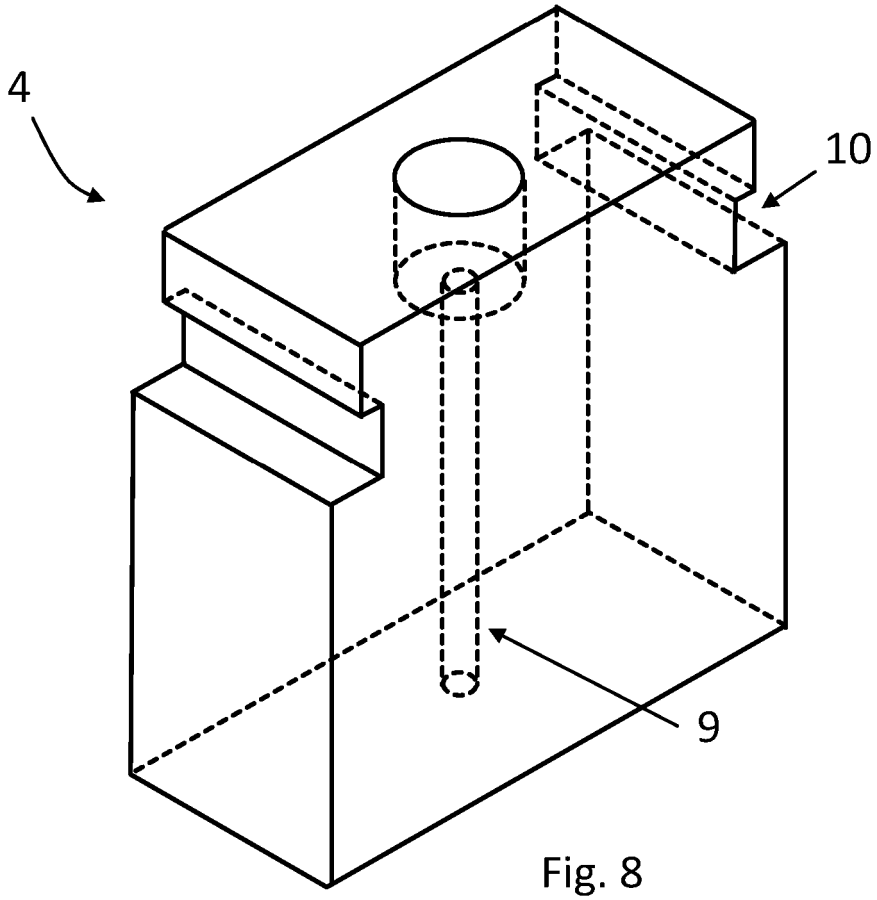

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 23 18 0486

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 2 925 930 A1 (PLASSER & THEURER EXPORT VON BAHNBAUMASCHINEN GMBH [AT]) 7 October 2015 (2015-10-07)	1-11	INV. E01B31/15 E01B31/17
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